Claims 1-31 are now pending in this application. Claims 1-29 stand rejected. Claims 30 and 31 are newly added. A fee calculation sheet for the newly added claims along with authorization to charge a deposit account in the amount of the calculated fee are submitted herewith.

Applicants note the objections to the drawings. Submitted herewith are substitute drawing sheets 1-4. No new matter has been added. For the reasons set forth above, Applicants respectfully request that the objections to the drawings be withdrawn.

The rejection of Claims 2, 3, 16 and 17 under 35 U.S.C. § 112 is respectfully traversed. More particularly, Claims 2 and 16 have been amended to recite "determining a vector distance $\vec{\mathbf{d}}$ between two antennas mounted to the locomotive." Furthermore, Claims 3 and 17 have been amended to recite "where ϕ represents a fractional phase part." As such, Applicants submit that Claims 2, 3, 16 and 17, as amended, do not omit essential elements and thus are not incomplete. For the reasons set forth above, Applicants respectfully request that the Section 112 rejections of Claims 2, 3, 16 and 17 be withdrawn.

The rejection of Claims 1-3 and 15-17 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,005,514 (Lightsey) is respectfully traversed.

Lightsey describes a method for vehicle attitude determination using GPS carrier phase measurements from nonaligned antennas. The method includes determining S10 the configuration of GPS patch antennas 10 on a vehicle 52, that includes master and slave antennas. Antenna reference frames are then measured S12 and carrier signals are received S14 by each antenna. For each set of carrier signals, a corrected, differential carrier phase is then determined S14. The corrected differential carrier phase measurements, along with other necessary inputs, are then used with conventional methods to determine an attitude of vehicle 52. The other necessary inputs may include the position of vehicle 52, GPS almanac information, and receiver to GPS line of sight information.

Claim 1 recites a method for determining at least one of motion and location parameters of a locomotive, wherein the method comprises the steps of "determining a set of phase differences between satellite reference signals received by satellite receivers...determining an accurate heading of the locomotive using the set of phase differences between the satellite reference signals."

Lightsey does not describe nor suggest a method for determining at least one of motion and location parameters of a locomotive, wherein the method includes determining an accurate heading of the locomotive using a set of phase differences between satellite reference signals. Specifically, Lightsey does not describe nor suggest a method for determining an accurate heading of a locomotive. Rather, Lightsey describes a method of vehicle attitude determination using GPS carrier phase measurements from nonaligned antennas. Furthermore at column 9, lines 44-48, Lightsey recites that "[a] further object of the present invention is to provide the capability of determining an attitude of a vehicle using GPS carrier signals by providing correction terms for differential phase measurements of GPS carrier signals received from nonaligned antennas." Accordingly, Applicants submit that Lightsey does not describe nor suggest a method for determining an accurate heading of a locomotive. For at least the reasons set forth above, Claim 1 is submitted to be patentable over Lightsey.

Claims 2 and 3 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 2 and 3 are considered in combination with the recitations of Claim 1, Applicants submit that Claims 2 and 3 likewise are patentable over Lightsey.

Claim 15 recites an apparatus for determining at least one of motion and location parameters of a locomotive to detect curves and reduce track wear, wherein the apparatus comprises "at least two phase-locking satellite receivers configured to reference signals received from a set of satellites...a processor configured to determine a set of phase differences between the reference signals received by said satellite receivers and an accurate heading of the locomotive using the set of phase differences between the reference signals."

Lightsey does not describe nor suggest an apparatus for determining at least one of motion and location parameters of a locomotive to detect curves and reduce track wear, wherein the apparatus includes a processor configured to determine a set of phase differences between the reference signals received by satellite receivers and an accurate heading of the locomotive using the set of phase differences between the reference signals. Specifically, Lightsey does not describe nor suggest a processor configured to determine an accurate heading of a locomotive. Rather, Lightsey describes a method of vehicle attitude determination using GPS carrier phase measurements from nonaligned antennas. Furthermore, at column 9, lines 44-48, Lightsey recites that "[a] further object of the present invention is to provide the capability of determining an attitude of a vehicle using GPS carrier signals by providing correction terms for differential phase measurements of GPS carrier signals received from nonaligned antennas." Accordingly, Applicants submit that Lightsey does not describe nor suggest a processor configured to determine an accurate heading of a locomotive. For at least the reasons set forth above, Claim 15 is submitted to be patentable over Lightsey.

Claims 16 and 17 depend, directly or indirectly, from independent Claim 15. When the recitations of Claims 16 and 17 are considered in combination with the recitations of Claim 15, Applicants submit that Claims 16 and 17 likewise are patentable over Lightsey.

For the reasons set forth above, Applicants respectfully request that the Section 102 rejection of Claims 1-3 and 15-17 be withdrawn.

The rejection of Claims 4 and 18 under 35 U.S.C. § 103(a) as being unpatentable over Lightsey is respectfully traversed.

Lightsey is described above. Applicants respectfully submit that the Section 103 rejection of Claims 4 and 18 is not a proper rejection. The mere assertion that such a method and apparatus would have been obvious to one of ordinary skill in the art does not support a prima facia obvious rejection. Rather, each allegation of what would have been an obvious matter of design choice must always be supported by citation to some reference work recognized as

standard in the pertinent art and the Applicants given the opportunity to challenge the correctness of the assertion or the notoriety or repute of the cited reference. Applicants have not been provided with the citation to any reference supporting the combination made in the rejection. The rejection, therefore, fails to provide the Applicants with a fair opportunity to respond to the rejection, and fails to provide the Applicants with the opportunity to challenge the correctness of the rejection. In addition, and contrary to the suggestion in the Office Action, Applicants submit that the claimed invention would not have been obvious to one of ordinary skill in the art.

Furthermore, and to the extent understood, Lightsey does not describe nor suggest the claimed invention. More specifically, Claim 4 depends indirectly from independent Claim 1, which recites a method for determining at least one of motion and location parameters of a locomotive, wherein the method comprises the steps of "determining a set of phase differences between satellite reference signals received by satellite receivers...determining an accurate heading of the locomotive using the set of phase differences between the satellite reference signals."

Lightsey does not describe nor suggest a method for determining at least one of motion and location parameters of a locomotive, wherein the method includes determining an accurate heading of the locomotive using a set of phase differences between satellite reference signals. Specifically, Lightsey does not describe nor suggest a method for determining an accurate heading of a locomotive. Rather, Lightsey describes a method for vehicle attitude determination using GPS carrier phase measurements from nonaligned antennas. For at least the reasons set forth above, Claim 1 is submitted to be patentable over Lightsey.

Claim 4 depends indirectly from independent Claim 1. When the recitations of Claim 4 are considered in combination with the recitations of Claim 1, Applicants submit that Claim 4 likewise is patentable over Lightsey.

In addition, Claim 4 depends indirectly from independent Claim 1 and further recites "wherein said step of determining at least one of an accurate heading, heading rate, attitude, and

attitude rate of the locomotive further comprises the step of determining an attitude and an attitude rate of a locomotive using $\vec{\mathbf{d}}$, the heading using $\tan^{-1}\frac{d_x}{d_y}$, and heading rate using $\frac{\tan^{-1} d_z}{\sqrt{d_x^2 + d_y^2}}$." Lightsey does not describe nor suggest determining an attitude and an attitude rate of a locomotive using $\vec{\mathbf{d}}$, a heading using $\tan^{-1}\frac{d_x}{d_y}$, and a heading rate using $\frac{\tan^{-1} d_z}{\sqrt{d_x^2 + d_y^2}}$. For at least the reasons set forth above, Claim 4 is submitted to be patentable over Lightsey.

Claim 18 depends indirectly from independent Claim 15, which recites an apparatus for determining at least one of motion and location parameters of a locomotive to detect curves and reduce track wear, wherein the apparatus comprises "at least two phase-locking satellite receivers configured to reference signals received from a set of satellites...a processor configured to determine a set of phase differences between the reference signals received by said satellite receivers and an accurate heading of the locomotive using the set of phase differences between the reference signals."

Lightsey does not describe nor suggest an apparatus for determining at least one of motion and location parameters of a locomotive to detect curves and reduce track wear, wherein the apparatus includes a processor configured to determine a set of phase differences between the reference signals received by satellite receivers and an accurate heading of the locomotive using the set of phase differences between the reference signals. Specifically, Lightsey does not describe nor suggest a processor configured to determine an accurate heading of a locomotive. Rather, Lightsey describes a method for vehicle attitude determination using GPS carrier phase measurements from nonaligned antennas. For at least the reasons set forth above, Claim 15 is submitted to be patentable over Lightsey.

Claim 18 depends, indirectly, from independent Claim 15. When the recitations of Claim 18 are considered in combination with the recitations of Claim 15, Applicants submit that Claim 18 likewise is patentable over Lightsey.

In addition, Claim 18 depends indirectly from independent Claim 15 and further recites "wherein said processor further configured to determine an attitude and an attitude rate of the locomotive using $\vec{\mathbf{d}}$, a heading using $\tan^{-1}\frac{d_x}{d_y}$, and a heading rate using $\frac{\tan^{-1} d_z}{\sqrt{d_x^2 + d_y^2}}$." Lightsey does not describe nor suggest determining an attitude and an attitude rate of a locomotive using $\vec{\mathbf{d}}$, the heading using $\tan^{-1}\frac{d_x}{d_y}$, and heading rate using $\frac{\tan^{-1} d_z}{\sqrt{d_x^2 + d_y^2}}$. For the reasons set forth above, Claim 18 is submitted to be patentable over Lightsey.

For the reasons set forth above, Applicants respectfully request that the Section 103 rejection of Claims 4 and 18 be withdrawn.

The rejection of Claims 5-9, 12-14, 19-23, 28 and 29 under 35 U.S.C. § 103(a) as being unpatentable over Lightsey in view of U.S. Patent No. 6,218,961 (Gross et al.) is respectfully traversed.

Lightsey is described above. Gross et al. describe a location determination system (LDS) for determining a location of railway vehicles without using a network of trackside indicators. The LDS includes a Kalman filter 500, a track database 550, a turn out processor 540, and four different sensors, which may include a GPS 510, a tachometer 520, a gyro 530, and an accelerometer 560. Turn out processor 540 identifies on which of several possible track paths a vehicle may be traveling by combining sensors 510, 520, 530 and 560 with track database 550. Track database 550 may include data representing the identification of the track, the location of the track segments, the curvature of the track segments, the grade of the track, control points, and switch locations. Track heading is computed from the curvature and/or grade data points and

stored in track database 550. Vehicle heading is determined from gyro 530. The LDS computes a heading error by subtracting the track heading, stored in database 550, from the vehicle heading obtained from gyro 530 to determine on which path the vehicle is traveling.

Applicant respectfully submits that the Section 103 rejection of Claims 5-9, 12-14, 19-23, 28 and 29 is not a proper rejection. Obviousness cannot be established by merely suggesting that it would have been obvious to one of ordinary skill in the art to modify Lightsey according to the teachings of Gross et al. More specifically, as is well established, obviousness cannot be established by combining the teachings of the cited art to produce the claimed invention, absent some teaching, suggestion, or incentive supporting the combination. The present Section 103 rejection is based on a combination of teachings selected from multiple patents in an attempt to arrive at the claimed invention. Because there is no teaching nor suggestion in the cited art for the claimed combination, the Section 103 rejection appears to be based on a hindsight reconstruction in which isolated disclosures have been picked and chosen in an attempt to deprecate the present invention. Of course, such a combination is impermissible, and for this reason alone, Applicant requests that the Section 103 rejection of Claims 5-9, 12-14, 19-23, 28 and 29 be withdrawn.

Claims 5-9 and 12-14 depend, directly or indirectly, from independent Claim 1, which recites a method for determining at least one of motion and location parameters of a locomotive, wherein the method comprises the steps of "determining a set of phase differences between satellite reference signals received by satellite receivers...determining an accurate heading of the locomotive using the set of phase differences between the satellite reference signals."

Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a method for determining at least one of motion and location parameters of a locomotive, wherein the method includes determining an accurate heading of the locomotive using a set of phase differences between satellite reference signals. More particularly, neither Lightsey nor

Gross et al., considered alone or in combination, describe or suggest a method for determining an accurate heading of a locomotive using a set of phase differences between satellite reference signals. Rather, Lightsey describes a method for vehicle attitude determination using GPS carrier phase measurements from nonaligned antennas, and Gross et al. describe a method for determining the location of railway vehicles, wherein a location determination system (LDS) determines the heading of a vehicle using a gyro, track curvature data and track grade data. For at least the reasons set forth above, Claim 1 is submitted to be patentable over Lightsey in view of Gross et al.

Claims 5-9 and 12-14 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 5-9 and 12-14 are considered in combination with the recitations of Claim 1, Applicants submit that Claims 5-9 and 12-14 likewise are patentable over Lightsey in view of Gross et al.

In addition, Claim 6 depends indirectly from Claim 1 and further recites "wherein determining a track curvature comprises the step of detecting an angular rotation rate ω and a velocity v of the locomotive, wherein $C=\omega/v$." Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a method for determining a track curvature C, wherein the method includes detecting an angular rotation rate ω and a velocity v of the locomotive, wherein $C=\omega/v$. Rather, Gross et al. describes determining track curvature from track curvature data stored in a track database, and Lightsey does not describe determining a track curvature. For this additional reason, Claim 6 is submitted to be patentable over Lightsey in view of Gross et al.

Claim 9 depends indirectly from Claim 1 and further recites "wherein determining a track curvature comprises the step of determining a lateral acceleration a and a velocity v of the locomotive, wherein $C=a/v$." Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a method for determining a track curvature, wherein the method includes determining a lateral acceleration a and a velocity v of the locomotive, wherein

$C=a/v$. Rather, Gross et al. describes determining track curvature from track curvature data stored in a track database, and Lightsey does not describe determining a track curvature. For this additional reason, Claim 9 is submitted to be patentable over Lightsey in view of Gross et al.

Claim 13 depends indirectly from Claim 1 and further recites the steps of "sampling latitude and longitude from the satellite receivers...determining a distance traveled by the locomotive." Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a method for determining at least one of motion and location parameters of a locomotive, wherein the method includes sampling latitude and longitude from satellite receivers, and determining a distance traveled by a locomotive. For this additional reason, Claim 13 is submitted to be patentable over Lightsey in view of Gross et al.

Claim 14 depends indirectly from Claim 1 and further recites "wherein said step of sampling latitude and longitude from the satellite receivers further comprises the steps of: sampling where the distance between the samples is determined as $\Delta d = R[\Delta lat^2 + \cos^2(lat)\Delta long^2]^{1/2}$, where Δlat is a difference between latitudes of consecutive measurements...$\Delta long$ is a difference between longitudes of consecutive measurements...R is the radius of the earth (about 3,440 nmi)...said step of determining a distance traveled by the locomotive further comprises the step of summing Δd over successive measurements." Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a method for determining at least one of motion and location parameters of a locomotive, wherein the method includes: sampling latitude and longitude from satellite receivers, wherein the distance between the samples is determined as $\Delta d = R[\Delta lat^2 + \cos^2(lat)\Delta long^2]^{1/2}$, and where Δlat is a difference between latitudes of consecutive measurements, $\Delta long$ is a difference between longitudes of consecutive measurements, and R is the radius of the earth (about 3,440 nmi); and summing Δd over successive measurements. For this additional reason, Claim 14 is submitted to be patentable over Lightsey in view of Gross et al.

Claims 19-23, 28 and 29 depend, directly or indirectly, from independent Claim 15, which recites an apparatus for determining at least one of motion and location parameters of a locomotive to detect curves and reduce track wear, wherein the apparatus comprises "at least two phase-locking satellite receivers configured to reference signals received from a set of satellites...a processor configured to determine a set of phase differences between the reference signals received by said satellite receivers and an accurate heading of the locomotive using the set of phase differences between the reference signals."

Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest an apparatus for determining at least one of motion and location parameters of a locomotive to detect curves and reduce track wear, wherein the apparatus includes a processor configured to determine a set of phase differences between the reference signals received by satellite receivers and an accurate heading of the locomotive using the set of phase differences between the reference signals. Specifically, neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a processor configured to determine an accurate heading of a locomotive using a set of phase differences between reference signals. Rather, Lightsey describes a method for vehicle attitude determination using GPS carrier phase measurements from nonaligned antennas, and Gross et al. describe a location determination system (LDS) for determining the location of railway vehicles, wherein the LDS determines the heading of a vehicle using a gyro, track curvature data and track grade data stored in a track database. For at least the reasons set forth above, Claim 15 is submitted to be patentable over Lightsey in view of Gross et al.

Claims 19-23, 28 and 29 depend, directly or indirectly, from independent Claim 15. When the recitations of Claims 19-23, 28 and 29 are considered in combination with the recitations of Claim 15, Applicants submit that Claims 19-23, 28 and 29 likewise are patentable over Lightsey in view of Gross et al.

In addition, Claim 20 depends indirectly from Claim 15 and further recites "wherein to determine a track curvature, said processor configured to detect an angular rotation rate ω and velocity v of the locomotive." Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a processor configured to detect an angular rotation rate ω and velocity v of a locomotive, to determine track curvature. For this additional reason, Claim 20 is submitted to be patentable over Lightsey in view of Gross et al.

Claim 23 depends indirectly from Claim 15 and further recites "wherein to determine a track curvature, said processor further configured to: determine a lateral acceleration a and a velocity v of the locomotive...determine track curvature C as: $C=a/v$." Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a processor configured to determine a lateral acceleration a and a velocity v of the locomotive to determine track curvature C as: $C=a/v$. For this additional reason, Claim 23 is submitted to be patentable over Lightsey in view of Gross et al.

Claim 28 depends indirectly from Claim 15 and further recites "said processor further configured to sample latitude and longitude from the GPS receivers...determine a distance traveled by the locomotive." Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a processor configured to sample latitude and longitude from GPS receivers and determine a distance traveled by the locomotive. For this additional reason, Claim 28 is submitted to be patentable over Lightsey in view of Gross et al.

Claim 29 depends indirectly from Claim 15 and further recites "wherein said processor is configured to determine a distance between samples as: $\Delta d = R[\Delta lat^2 + \cos^2(lat)\Delta long^2]^{1/2}$." Neither Lightsey nor Gross et al., considered alone or in combination, describe or suggest a processor configured to determine a distance between samples as: $\Delta d = R[\Delta lat^2 + \cos^2(lat)\Delta long^2]^{1/2}$. For this additional reason, Claim 29 is submitted to be patentable over Lightsey in view of Gross et al.

For the reasons set forth above, Applicants respectfully request that the Section 103 rejection of Claims 5-9, 12-14, 19-23, 28 and 29 be withdrawn.

The rejection of Claims 10, 11 and 24-27 under 35 U.S.C. § 103(a) as being unpatentable over Lightsey in view of Gross et al., and further in view of U.S. Patent No. 5,896,947 (Kumar) is respectfully traversed.

Lightsey is described above. Gross et al. are described above. Kumar describes a method for simultaneously lubricating the rail gage side (RAGS) and wheel flanges ahead of a locomotive's 1 tractive wheels and lubricating the top of the rail (TOR) behind the tractive wheels to reduce the resistance of the trailing cars and reduce the locomotive wheel flange wear. The method includes controlling both lubricating units with the same computer controller 2 when a single locomotive 1 is used and two controllers 2F, 2R located in two different locomotives 1 in the case of a train consist 10.

Claims 10 and 11 depend, directly or indirectly, from independent Claim 1, which recites a method for determining at least one of motion and location parameters of a locomotive, wherein the method comprises the steps of "determining a set of phase differences between satellite reference signals received by satellite receivers...determining an accurate heading of the locomotive using the set of phase differences between the satellite reference signals."

None of Lightsey, Gross et al., nor Kumar, considered alone or in combination, describe or suggest a method for determining at least one of motion and location parameters of a locomotive, wherein the method includes determining an accurate heading of the locomotive using a set of phase differences between satellite reference signals. More specifically, none of Lightsey, Gross et al., nor Kumar, considered alone or in combination, describe or suggest a method for determining an accurate heading of a locomotive using a set of phase differences between satellite reference signals. Rather, Lightsey describes a method for vehicle attitude determination using GPS carrier phase measurements from nonaligned antennas, and Gross et al. describe a method for determining the location of railway vehicles, wherein a location

determination system (LDS) determines the heading of a vehicle using a gyro, track curvature data and track grade data. Furthermore, Kumar describe a method for simultaneously lubricating the rail gage side (RAGS) and wheel flanges ahead of a locomotive's tractive wheels and lubricating the top of the rail (TOR) behind the locomotive's tractive wheels. For at least the reasons set forth above, Claim 1 is submitted to be patentable over Lightsey in view of Gross et al., and further in view of Kumar.

Claims 10 and 11 depend, directly or indirectly, from independent Claim 1. When the recitations of Claims 10 and 11 are considered in combination with the recitations of Claim 1, Applicants submit that Claims 10 and 11 likewise are patentable over Lightsey in view of Gross et al., and further in view of Kumar.

Claims 24-27 depend, directly or indirectly, from independent Claim 15, which recites an apparatus for determining at least one of motion and location parameters of a locomotive to detect curves and reduce track wear, wherein the apparatus comprises "at least two phase-locking satellite receivers configured to reference signals received from a set of satellites...a processor configured to determine a set of phase differences between the reference signals received by said satellite receivers and an accurate heading of the locomotive using the set of phase differences between the reference signals."

None of Lightsey, Gross et al., nor Kumar, considered alone or in combination, describe or suggest an apparatus for determining at least one of motion and location parameters of a locomotive to detect curves and reduce track wear, wherein the apparatus includes a processor configured to determine a set of phase differences between the reference signals received by satellite receivers and an accurate heading of the locomotive using the set of phase differences between the reference signals. More specifically, none of Lightsey, Gross et al., nor Kumar, considered alone or in combination, describe or suggest a processor configured to determine an accurate heading of the locomotive using a set of phase differences between reference signals. Rather, Lightsey describes a method for vehicle attitude determination using GPS carrier phase

measurements from nonaligned antennas, and Gross et al. describe a location determination system (LDS) for determining the location of railway vehicles, wherein the LDS determines the heading of a vehicle using a gyro, track curvature data and track grade data. Furthermore, Kumar describes a method for simultaneously lubricating the rail gage side (RAGS) and wheel flanges ahead of a locomotive's tractive wheels and lubricating the top of the rail (TOR) behind the tractive wheels. For at least the reasons set forth above, Claim 15 is submitted to be patentable over Lightsey in view of Gross et al., and further in view of Kumar.

Claims 24-27 depend, directly or indirectly, from independent Claim 15. When the recitations of Claims 24-27 are considered in combination with the recitations of Claim 15, Applicants submit that Claims 24-27 likewise are patentable over Lightsey in view of Gross et al., and further in view of Kumar.

For the reasons set forth above, Applicants respectfully request that the Section 103 rejection of Claims 10, 11 and 24-27 be withdrawn.

With respect to the newly added Claims, Claim 30 depends from independent Claim 1, which is submitted to be in condition for allowance. When the recitations of Claim 30 are considered in combination with the recitations of Claim 1, Applicants submit that Claim 30 likewise is in condition for allowance.

Claim 31 depends indirectly from independent Claim 15, which is submitted to be in condition for allowance. When the recitations of Claim 31 are considered in combination with the recitations of Claim 15, Applicants submit that Claim 31 likewise is in condition for allowance.

In view of the foregoing amendments and remarks, all the claims now active in this application are believed to be in condition for allowance. Reconsideration and favorable action is respectfully solicited.

Respectfully Submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Zahm et al.	:	
	:	Art Unit: 3661
Serial No.: 09/585,192	:	
	:	Examiner: B. Broadhead
Filed: June 1, 2000	:	
	:	
For: METHODS AND APPARATUS FOR MEASURING NAVIGATIONAL PARAMETERS OF A LOCOMOTIVE	:	

SUBMISSION OF MARKED UP CLAIMS

Hon. Assistant Commissioner for Patents
Washington, D.C. 20231

Submitted herewith are marked up claims in accordance with 37 C.F.R. 1.121(c)(1)(ii).

MARKED UP CLAIMS

1. (once amended) A method for determining at least one of motion and location parameters of a locomotive, said method comprising the steps of:

determining a set of phase differences between satellite reference signals received by satellite receivers; and

determining [at least one of] an accurate heading[, heading rate, attitude, and attitude rate] of the locomotive using the set of phase differences between the satellite reference signals.

2. (once amended) A method according to Claim 1 further comprising the step of determining a vector distance $\vec{\mathbf{d}}$ between two antennas mounted to the locomotive.

3. (once amended) A method according to Claim 2 further comprising the step of determining $\vec{\mathbf{d}}$ as $\vec{\mathbf{d}} = (\mathbf{H}^T\mathbf{H})^{-1}\mathbf{H}^T\vec{\mathbf{y}}$, where:

$$\mathbf{H} = \begin{bmatrix} LOS_x^1 & LOS_y^1 & LOS_z^1 \\ LOS_x^2 & LOS_y^2 & LOS_z^2 \\ \vdots & \vdots & \vdots \\ LOS_x^n & LOS_y^n & LOS_z^n \end{bmatrix};$$

$$\vec{\mathbf{y}} = \begin{bmatrix} \Delta\phi^1 - \lambda(N_1^1 - N_2^1) - c(dt_1 - dt_2) \\ \Delta\phi^2 - \lambda(N_1^2 - N_2^2) - c(dt_1 - dt_2) \\ \vdots \\ \Delta\phi^n - \lambda(N_1^n - N_2^n) - c(dt_1 - dt_2) \end{bmatrix}; \text{ and}$$

$$\vec{\mathbf{d}} = \begin{bmatrix} d_x \\ d_y \\ d_z \end{bmatrix}, \text{ where } \phi \text{ represents a fractional phase part.}$$

4. (once amended) A method according to Claim [3] 30 wherein said step of determining at least one of an accurate heading, heading rate, attitude, and attitude rate of the locomotive further comprises the step of determining an attitude and an attitude rate of a locomotive using $\vec{\mathbf{d}}$, the heading using $\tan^{-1}\frac{d_x}{d_y}$, and heading rate using $\frac{\tan^{-1} d_z}{\sqrt{d_x^2 + d_y^2}}$.

15. (once amended) An apparatus for determining at least one of motion and location parameters of a locomotive to detect curves and reduce track wear, said apparatus comprising:

at least two phase-locking satellite receivers configured to reference signals received from a set of satellites; and

a processor configured to determine a set of phase differences between the reference signals received by said satellite receivers and [at least one of] an accurate heading[, heading rate, attitude, and attitude rate] of the locomotive using the set of phase differences between the reference signals.

16. (once amended) An apparatus according to Claim 15 wherein said processor further configured to determine a vector distance $\vec{\mathbf{d}}$ between two antennas mounted to the locomotive.

17. (once amended) An apparatus according to Claim 16 wherein said processor further configured to determine $\vec{\mathbf{d}}$ as $\vec{\mathbf{d}} = (\mathbf{H}^T\mathbf{H})^{-1}\mathbf{H}^T\vec{\mathbf{y}}$, where:

$$\mathbf{H} = \begin{bmatrix} LOS_x^1 & LOS_y^1 & LOS_z^1 \\ LOS_x^2 & LOS_y^2 & LOS_z^2 \\ \vdots & \vdots & \vdots \\ LOS_x^n & LOS_y^n & LOS_z^n \end{bmatrix};$$

$$\vec{\mathbf{y}} = \begin{bmatrix} \Delta\phi^1 - \lambda(N_1^1 - N_2^1) - c(dt_1 - dt_2) \\ \Delta\phi^2 - \lambda(N_1^2 - N_2^2) - c(dt_1 - dt_2) \\ \vdots \\ \Delta\phi^n - \lambda(N_1^n - N_2^n) - c(dt_1 - dt_2) \end{bmatrix}; \text{ and}$$

$\vec{\mathbf{d}} = \begin{bmatrix} d_x \\ d_y \\ d_z \end{bmatrix}$, where ϕ represents a fractional phase part.

18. (once amended) An apparatus according to Claim [17] 31 wherein said processor further configured to determine an attitude and an attitude rate of the locomotive using $\vec{\mathbf{d}}$, the heading using $\tan^{-1}\frac{d_x}{d_y}$, and the heading rate using $\frac{\tan^{-1} d_z}{\sqrt{d_x^2 + d_y^2}}$.

PLEASE ADD THE FOLLOWING NEW CLAIMS

30. A method in accordance with Claim 3, wherein said step of determining an accurate heading of the locomotive using the set of phase differences between the satellite reference signals further comprises determining at least one of an accurate heading rate, attitude, and attitude rate of the locomotive using the set of phase differences between the satellite reference signals.

31. An apparatus in accordance with Claim 17, wherein said processor further configured to determine at least one of an accurate heading rate, attitude, and attitude rate of the locomotive using the set of phase differences between the satellite reference signals.

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